Dejan Trbojevic

17 September 1999

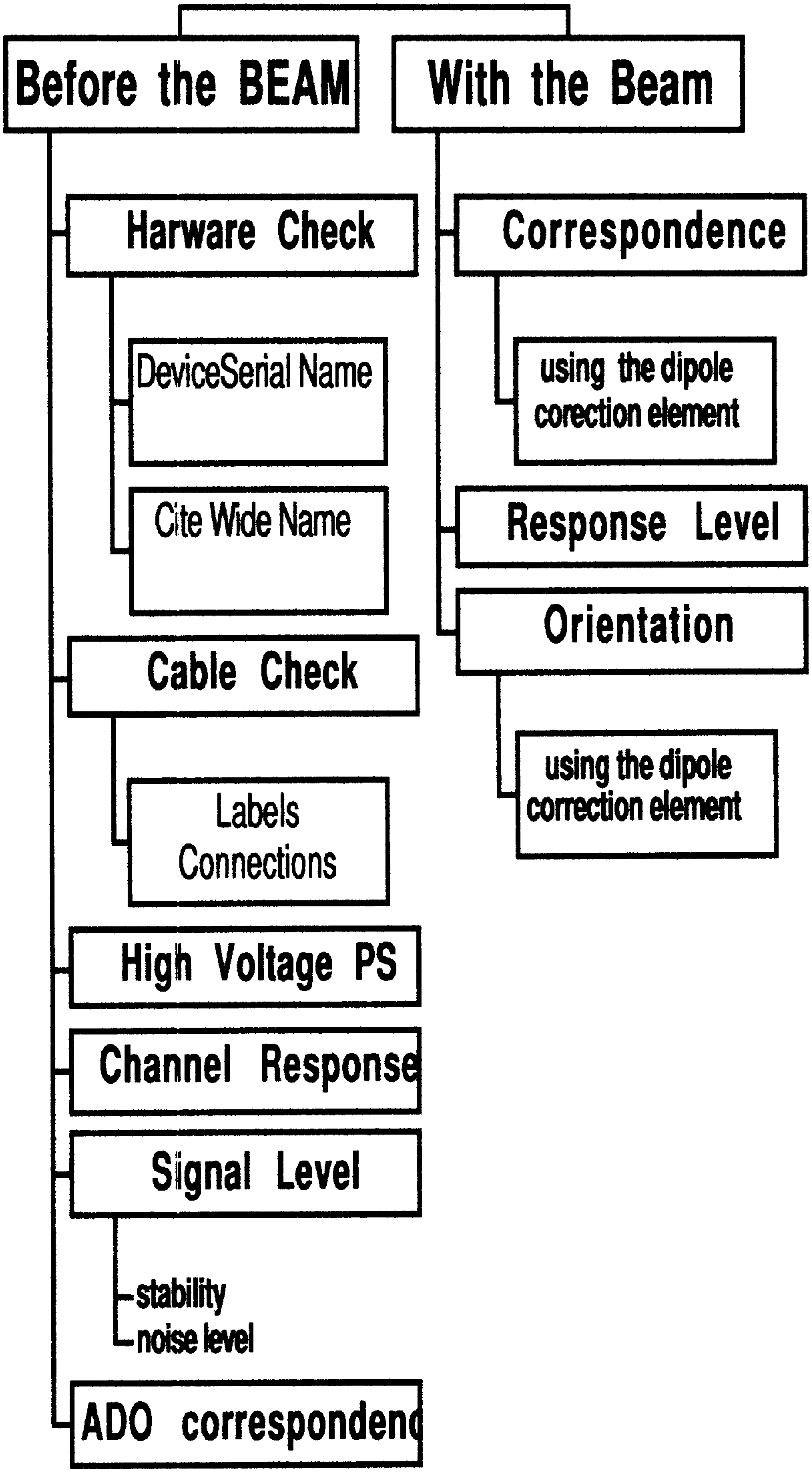
Beam Diagnostics & Instrumentation

What is essential for the next run and what would be nice to have?

Beam Diagnostics - Instruments

- *- **Detection Element***: has unique name from production serial name - device name (DCCT, flag plates, Wall current monitor "cylinder", ionization chambers for the loss monitors, multi-channel plates for IPM, plates for the Schottky detector, plates for the transverse damper kicker...)
- - ***Cable connections*** : cables have labels on both sides. They are either signal cables and other type (high voltage - IPM, loss monitors, tune kicker, or the current signals for the calibration of the DCCT)
- ***- Preamplifiers, amplifiers, integrators, high voltage power supplies, calibration current sources, digital signal processors***
- - ***Analog to Digital Converters (ADC or Multi channel - MADC):*** translation of the signals inside of the specific channels or digital signal processors
- - ***VME crates or FEC*** within the front end computers there are channels and local CPU which accept the translated signals
- - ***ADO or ADOIF*** - Accelerator Device Objects communicate to the crates
- - ***Software Programs and Managers*** - Communicate to the ADO's

SYSTEM CHECK



What would be nice to have ?

- **Improve the existing systems**
  - ***BPM system*** especially around the IR regions and allow the DX BPM's to provide signals from both "blue" and "yellow" beams
  - ***Schottky detectors*** should provide signals along the ramp
  - ***Make the IPM's*** operational - from the control room
  - ***Tune meter*** has to be able to measure the tunes along the ramp
  - ***DCCT's and the wall current monitors*** do not to need to be an expert activity
  - ***Connect the RF controls with the tune meter*** (chromaticity)
- **Make the AC dipole**
  - and measure the betatron functions
- **Make from the Schottky detectors signals**
  - beam profiles in the betatron tunes diagram

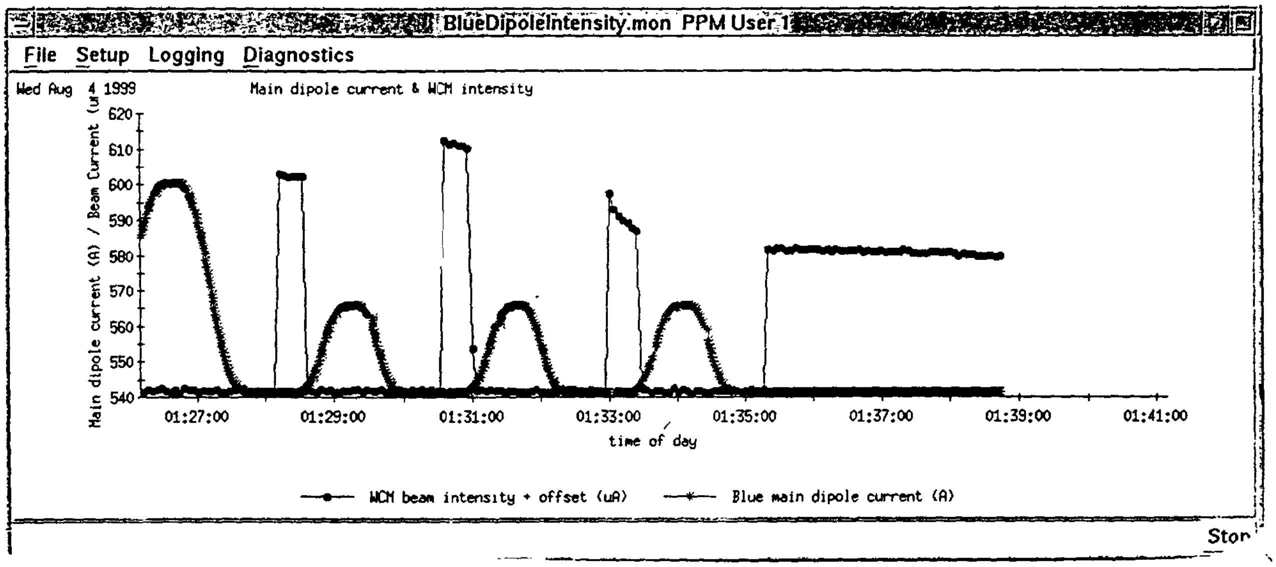
Schottky System – Lessons Learned & Plans

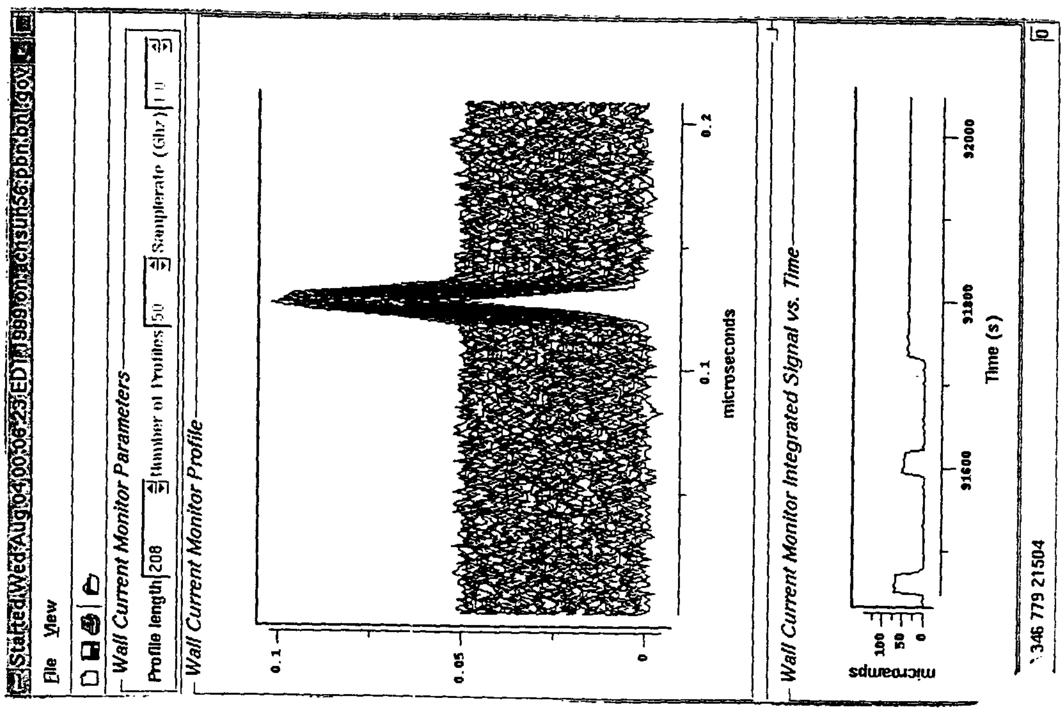
1. Best Display Award! Interactive X-window – HP 89410 w/ LAN option

2. Get it while you can!

3. The Data – documented and anecdotal

4. "Schottky Day One" – Future Plans (all histories?)
   a. relative emittance history – receiver (six receivers? multiplex?)
   b. betatron tune history
      1. waterfall
      2. on resonance diagram
   c. synchrotron tune history
   d. momentum spread history – line width
   e. beam-beam tune spread and shift histories – requires stored single beam benchmark specta


BlueDipoleIntensity.mon PPM User 1
File Setup Logging Diagnostics
Wed Aug 4 1999
Main dipole current & WCM intensity
Main dipole current (A) / Beam Current (uA)
620
610
600
590
580
570
560
550
540
01:27:00
01:29:00
01:31:00
01:33:00
01:35:00
01:37:00
01:39:00
01:41:00
time of day
WCM beam intensity + offset (uA)
Blue main dipole current (A)


File View
Wall Current Monitor Parameters
Profile length 208
Number of Profiles 50
Samplerate (Ghz)
Wall Current Monitor Profile
0.1
0.05
0
0.1
0.2
microseconds
Wall Current Monitor Integrated Signal vs. Time
100
50
0
microamps
91600
91800
92000
Time (s)
346 779 21504

followed by detailed explanation which should also serve to justify the identification.

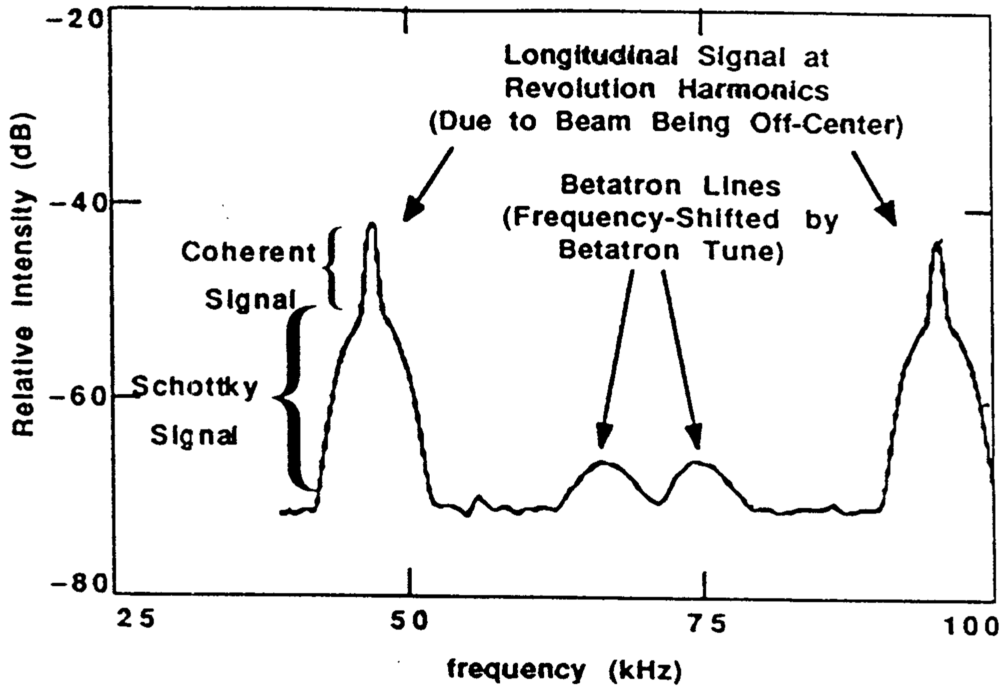


FIGURE 1 Spectrum of Vertical Output Signal from Schottky detector. E=273 GeV

The two large peaks at roughly 50 and 100 kHz are the longitudinal signals, variously known as revolution lines or (when they appear in a transverse detector which puts out a "difference" signal) common-mode lines. Their presence is due to the fact that the beam is not centered in the detector; in the spectrum coming directly from the detector (i.e., prior to heterodyning) they occur at integer multiples of the 47.7 kHz revolution

is produced by a *strong* coherent betatron line), a result consistent with its apparent total absence, as noted earlier.

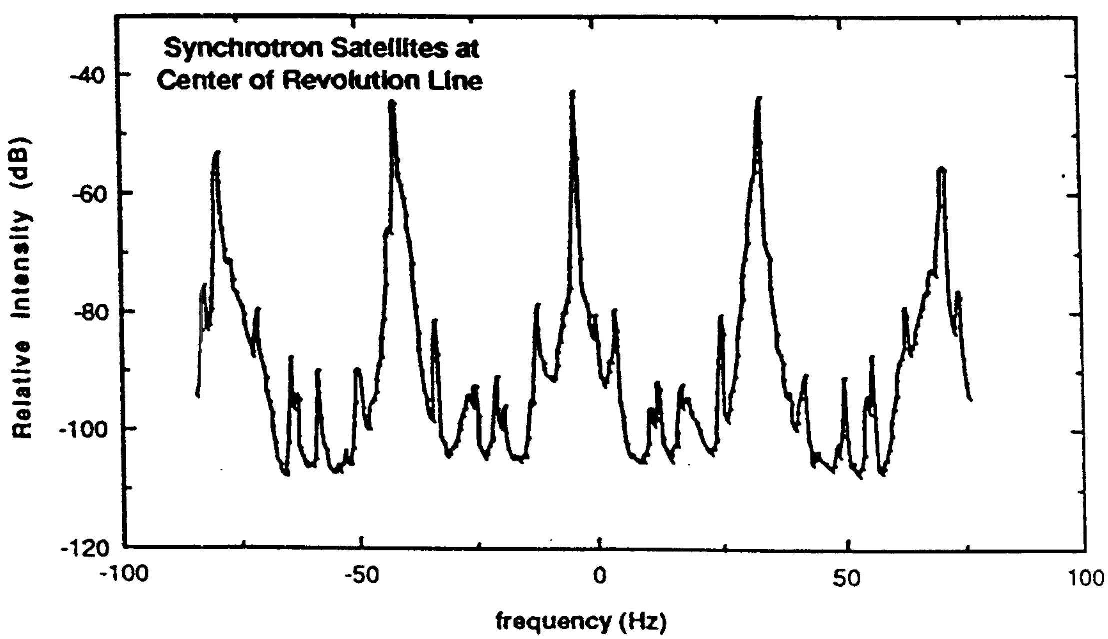
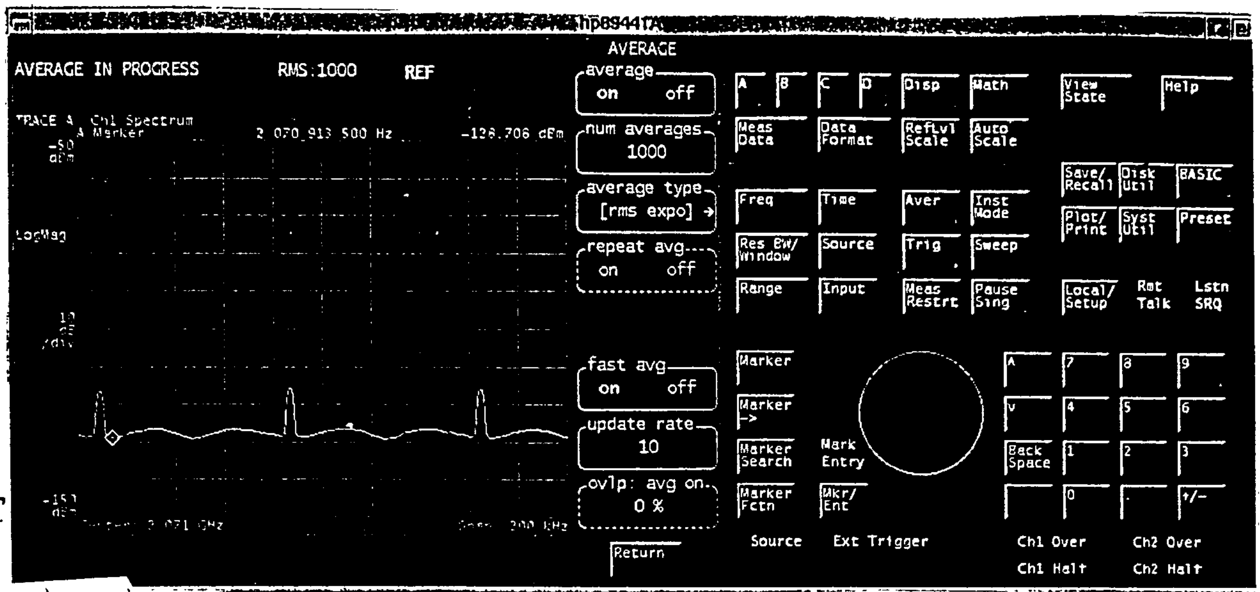


FIGURE 2 Central synchrotron satellites observed during opeation at ≈900 GeV.

Vert

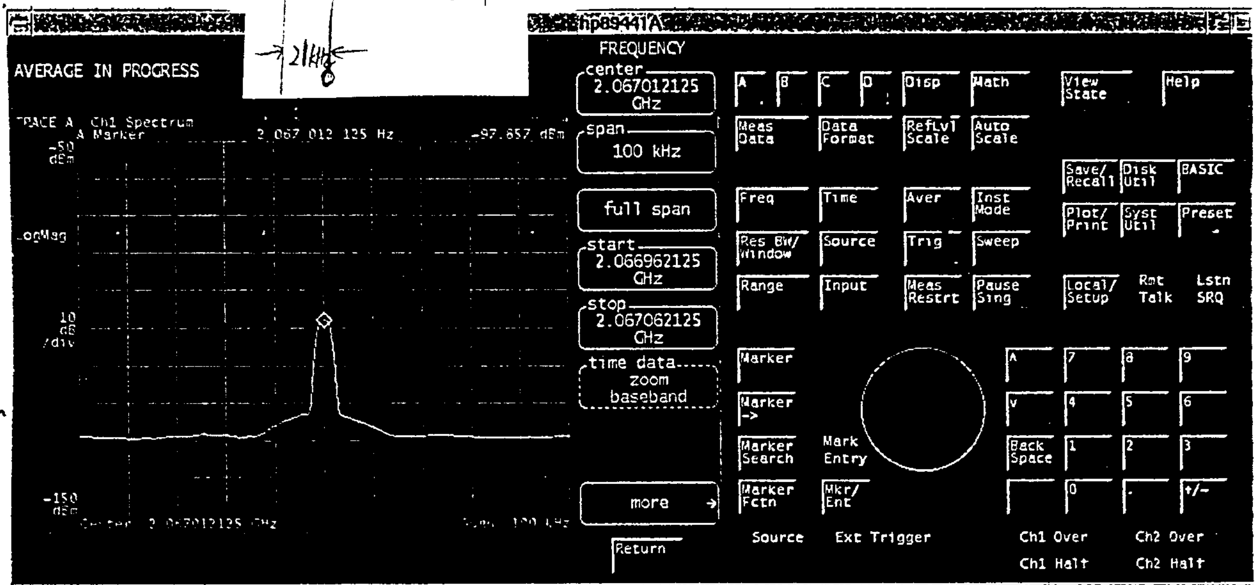
e signals on the right are the schottky signals from the schottky cavity study by P. Cameron. From these signals, we expect to measure the tune during the ramp. These signals are taken after injection. The vertical signal shows the schottky spectrum from betatron oscillation is about 21 kHz away from the revolution lines. The horizontal signal is different from the vertical one. The schottky spectrum from betatron oscillation about 24 kHz away from the revolution line is much weaker. The broad spectrum on top of the revolution line is from synch-rotron motion (?)



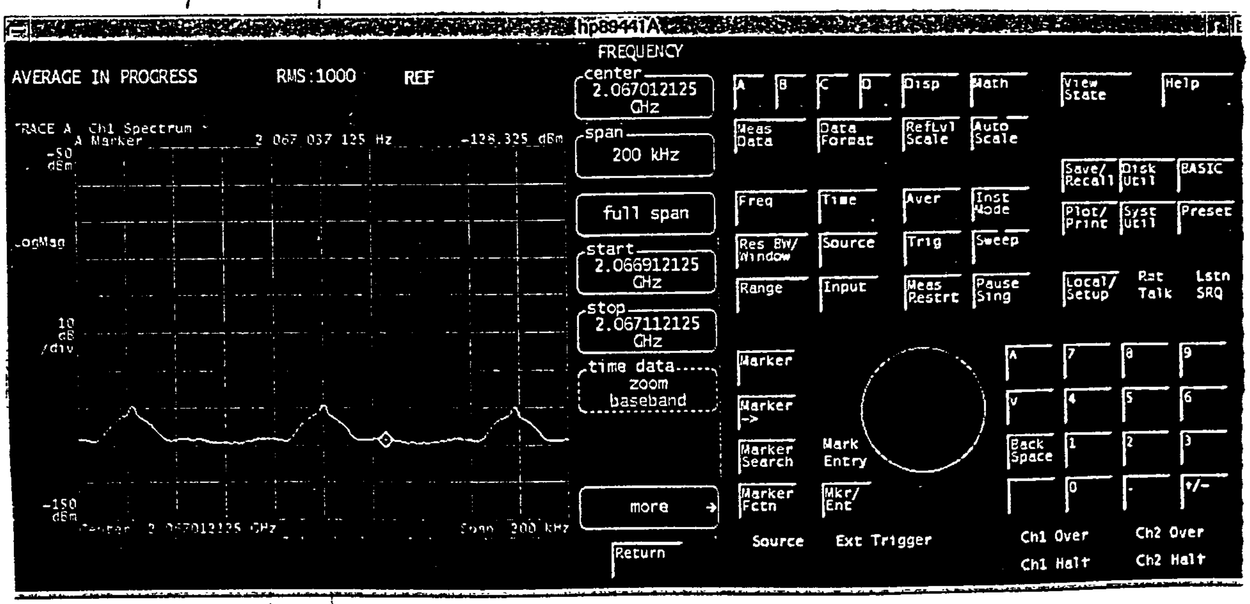
Hori

78 kHz

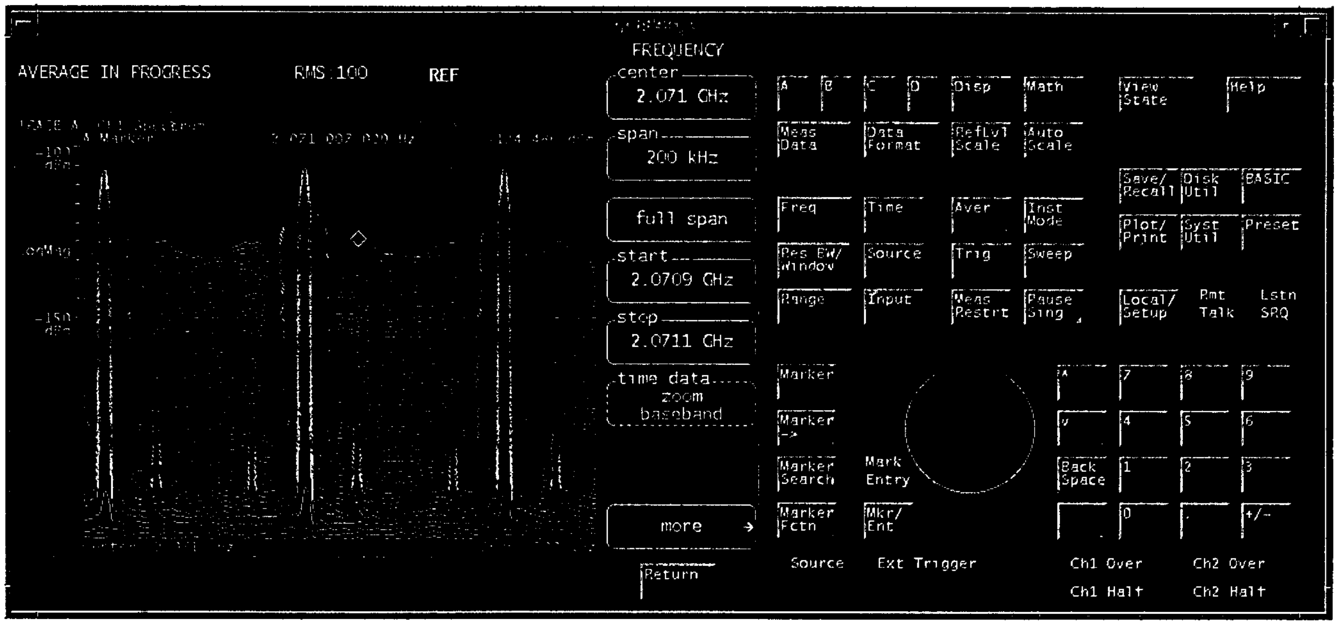
21 kHz



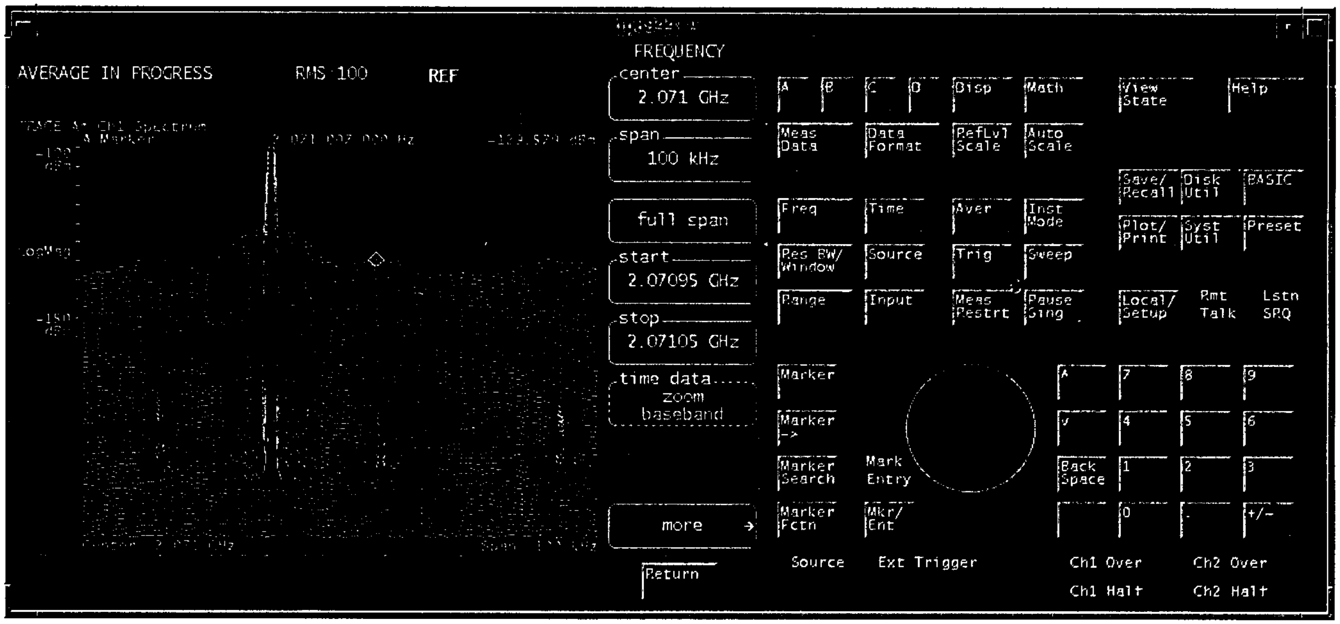
24 kHz



24 kHz



AVERAGE IN PROGRESS
RMS 100
REF
FREQUENCY
center
2.071 GHz
span
200 kHz
full span
start
2.0709 GHz
stop
2.0711 GHz
time data
zoom
baseband
more
Return
A
B
C
D
Disp
Math
View State
Help
Meas Data
Data Format
RefLvl Scale
Auto Scale
Save/ Recall
Disk Util
BASIC
Freq
Time
Aver
Inst Mode
Plot/ Print
Syst Util
Preset
Res BW/ Window
Source
Trig
Sweep
Range
Input
Meas Restrt
Pause Sing
Local/ Setup
Rmt Talk
Lstn SRQ
Marker
Marker ->
Marker Search
Mark Entry
Marker Fctn
Mkr/ Ent
7
8
9
4
5
6
Back Space
1
2
3
0
.
+/-
Source
Ext Trigger
Ch1 Over
Ch2 Over
Ch1 Half
Ch2 Half


AVERAGE IN PROGRESS
RMS 100
REF
FREQUENCY
center
2.071 GHz
span
100 kHz
full span
start
2.07095 GHz
stop
2.07105 GHz
time data
zoom
baseband
more
Return
A
B
C
D
Disp
Math
View State
Help
Meas Data
Data Format
RefLvl Scale
Auto Scale
Save/ Recall
Disk Util
BASIC
Freq
Time
Aver
Inst Mode
Plot/ Print
Syst Util
Preset
Res BW/ Window
Source
Trig
Sweep
Range
Input
Meas Restrt
Pause Sing
Local/ Setup
Rmt Talk
Lstn SRQ
Marker
Marker ->
Marker Search
Mark Entry
Marker Fctn
Mkr/ Ent
Back Space
+/-
Source
Ext Trigger
Ch1 Over
Ch2 Over
Ch1 Halt
Ch2 Halt

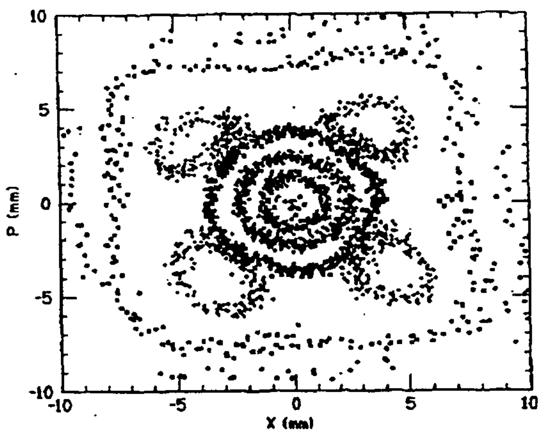


Figure 2.37: The measured Poincaré maps (x, p_x) of betatron motion near a fourth order resonance $4\nu_x = 15$ at the IUCF Cooler Ring.

study the concept of smear, nonlinear detuning, decoherence, and dynamical aperture.[80] Similarly, nonlinear beam dynamics studies at the IUCF Cooler Ring shows the importance of the nonlinear resonances. The nonlinear beam dynamics is beyond the scope of this introductory textbook. This section shows an example of the fourth order parametric resonance at $4\nu_x = 15$.[81]

Near a fourth order 1D resonance, the Hamiltonian can be approximated by

$$H = \nu_x J_x + \frac{1}{2}\alpha_{xx} J_x^2 + g J_x^2 \cos(4\psi_x - \ell\theta + \chi), \tag{2.387}$$

where the resonance strength g can be obtained from the Fourier transformation of the effective particle Hamiltonian in the synchrotron. Figure 2.37 shows the Poincaré maps near a fourth order resonance $4\nu_x = 15$ measured at the IUCF Cooler Ring. Note that when the betatron tune is exactly equal to 15/4, the betatron motion will be located at fixed points of the 4th order resonance island. Small deviation from the fixed points will execute motion around the stable fixed points shown in Fig. 2.37. In this particular example, the 4th order resonance islands are enclosed by stable invariant tori.

Figure 2.38 shows another example of the fourth order resonance.[82] The left plot shows the Poincaré map in (x, p_x) phase space for 3584 orbital revolutions. The data points located at the origin of the Poincaré map correspond to beam bunch positions

[80]A. Chao, et al., Phys. Rev. Lett. **61**, 2752 (1988); N. Merminga, et al., Proc. EPAC, p.791 (1988); T. Satogata, et al., Phys. Rev. Lett., **68**, 1838 (1992); T. Satogata, Ph. D. Thesis, Northwestern University, 1993 unpublished. T. Chen et al., Phys. Rev. Lett. **68**, 33 (1992).

[81]S.Y. Lee, et al., Phys. Rev. Lett. **67**, 3768 (1991); M. Ellison *et al.*, *Betatron coupling correction at the IUCF Cooler, leading to improved determination of Fourth order resonance Hamiltonian*, AIP conf. Proc. No. 292, edited by M. Month, A.G. Ruggiero, and W.T. Weng, p.170 (1992).

[82]Y. Wang, *et al.*, Phys. Rev. E49, 5697 (1994).

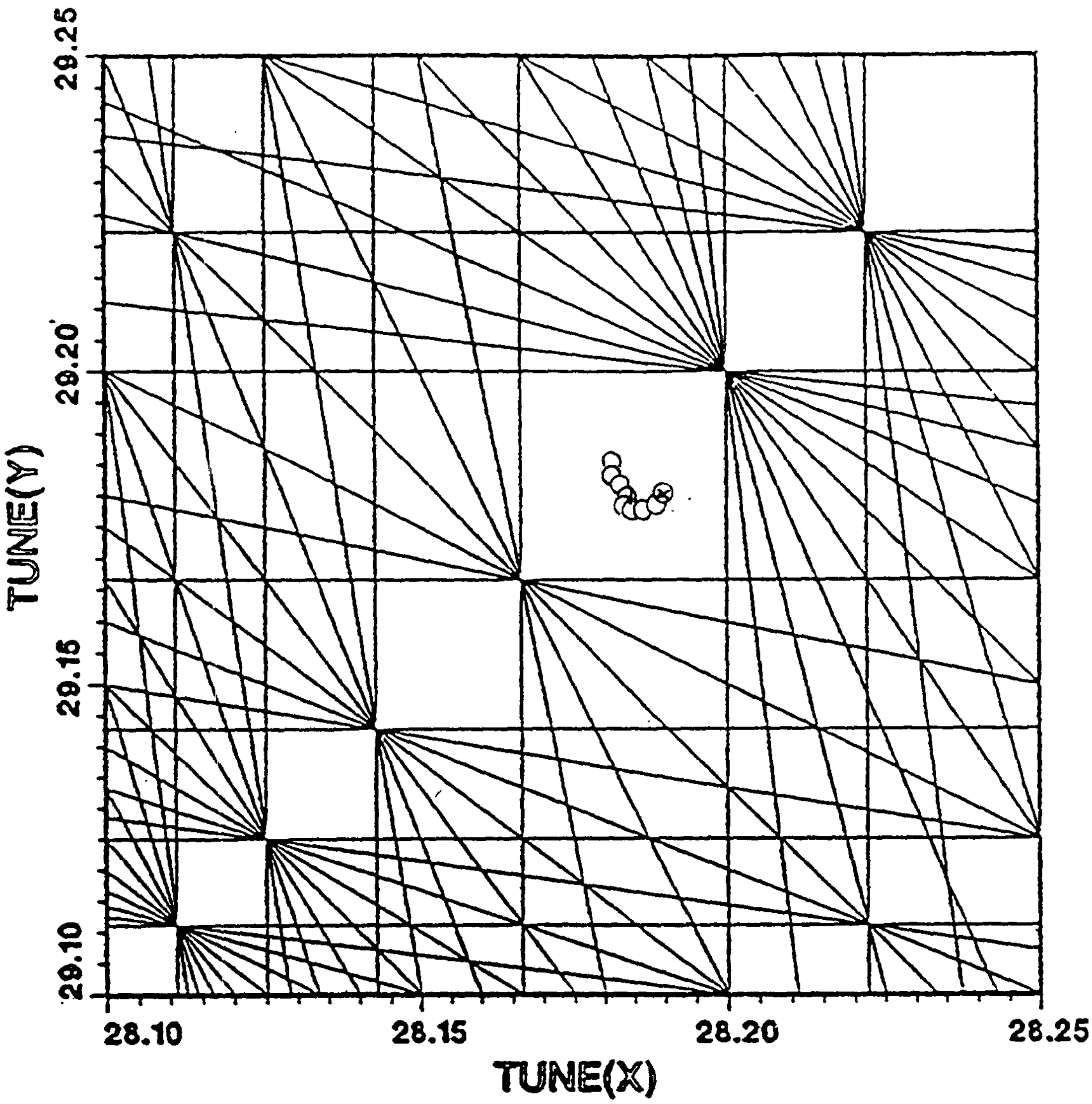
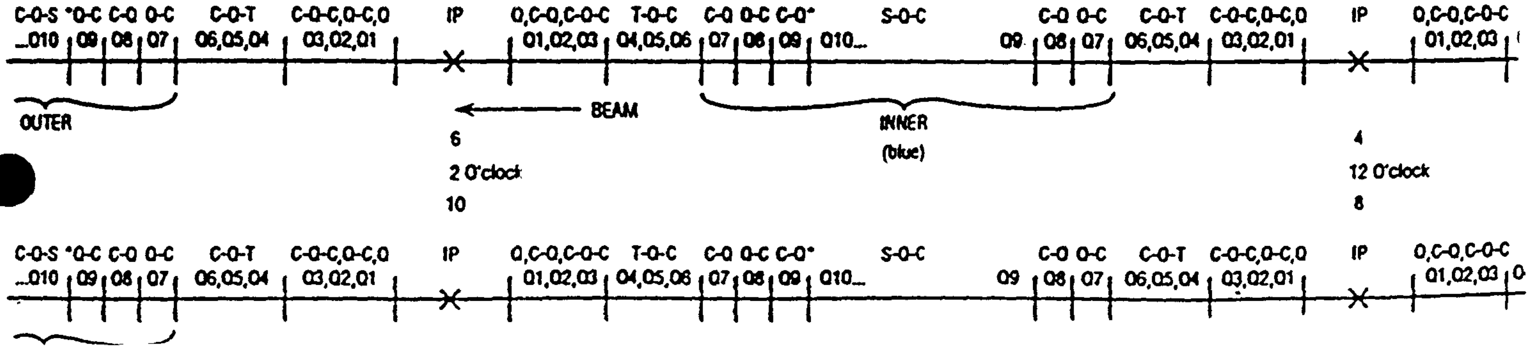
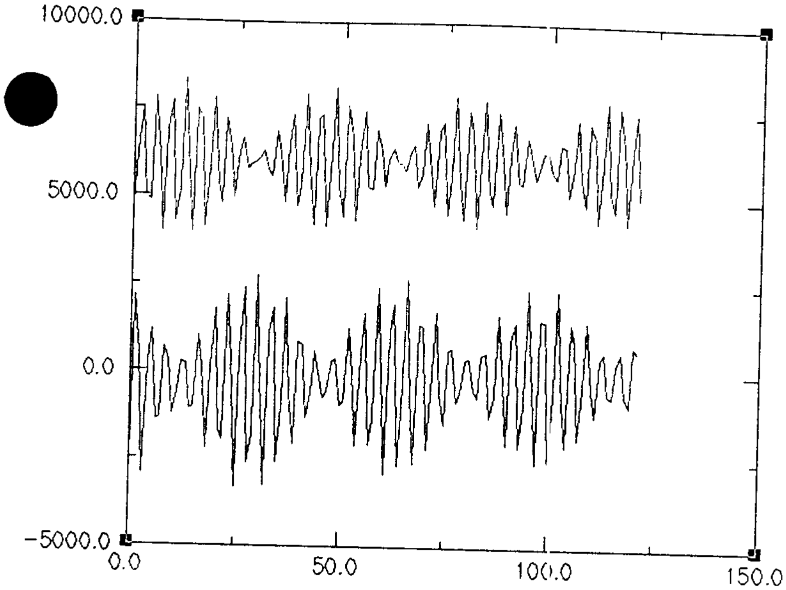


Fig. 11-15. Tune diagram showing the selected working point of RHIC at ν_y = 29.18 with neighboring sum and difference resonances.



before Tune change

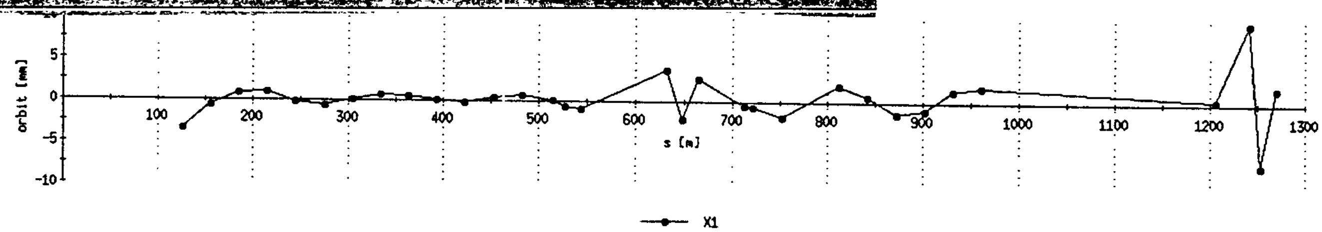


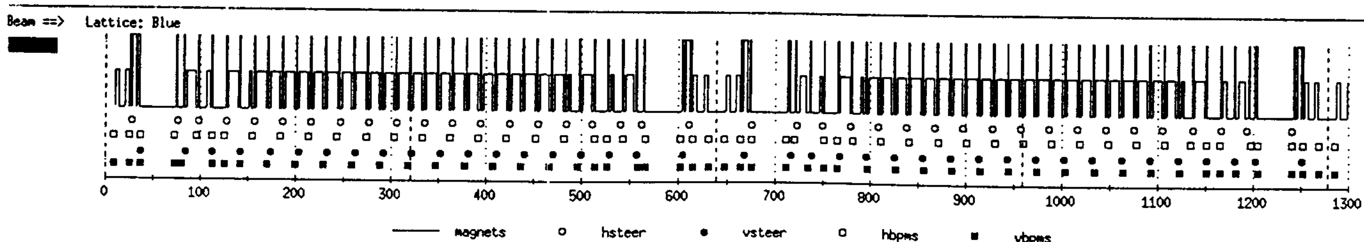
:0.0, Thu Aug 5 12:23:11 1999, tune.dat

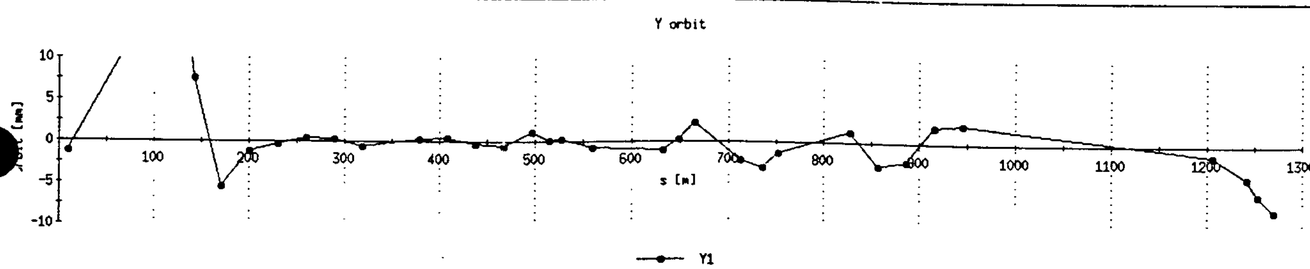
5, :0.0, Thu Aug 5 12:23:11 1999, tune.dat

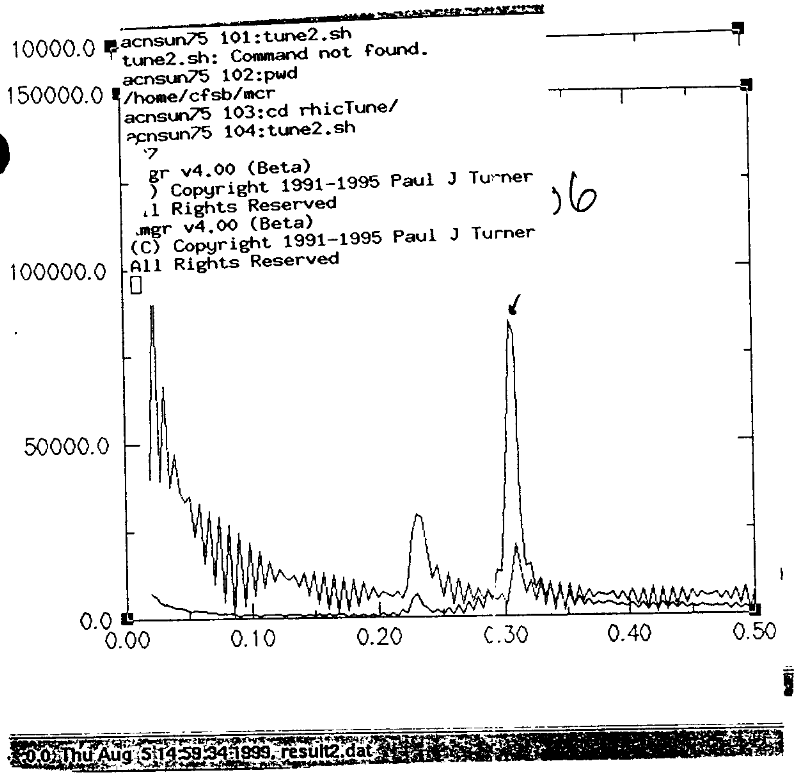
Help

75, :0.0, Thu Aug 5 12:34:14 1999, tune.dat

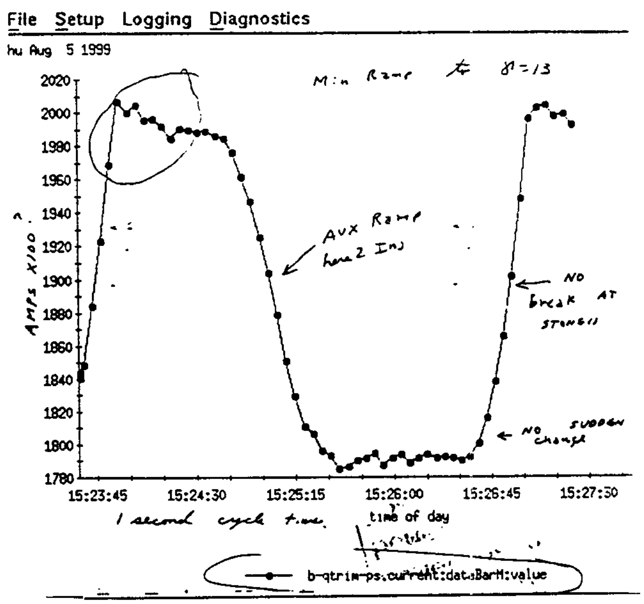




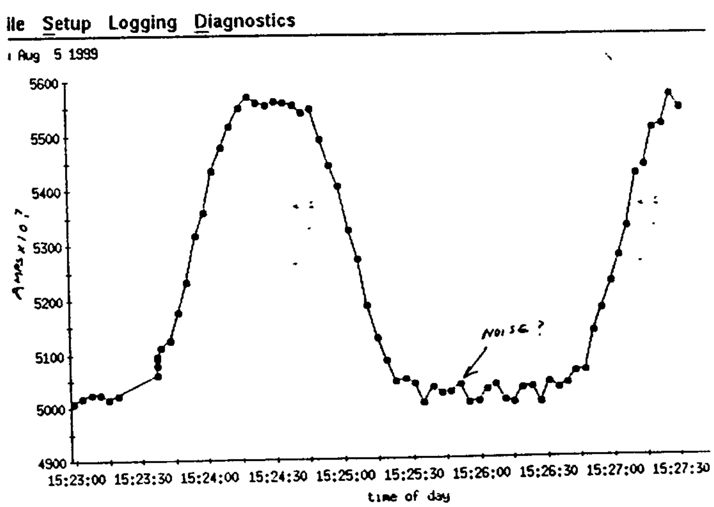


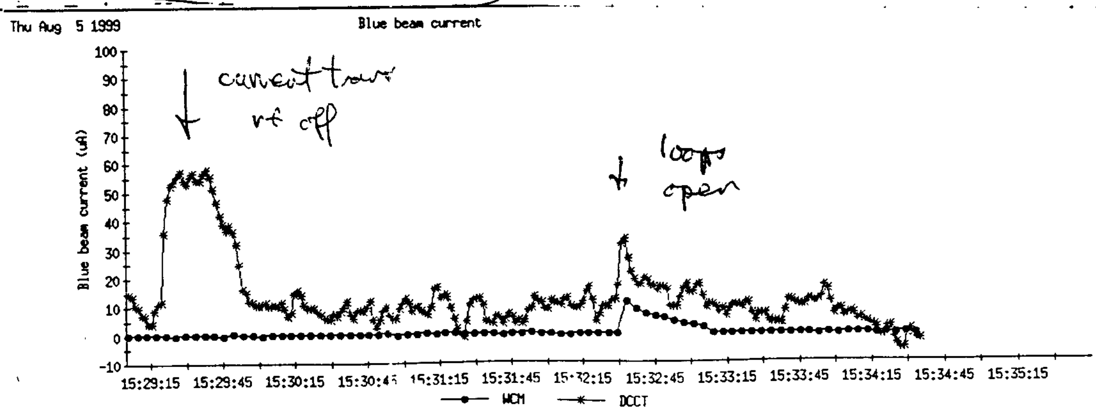


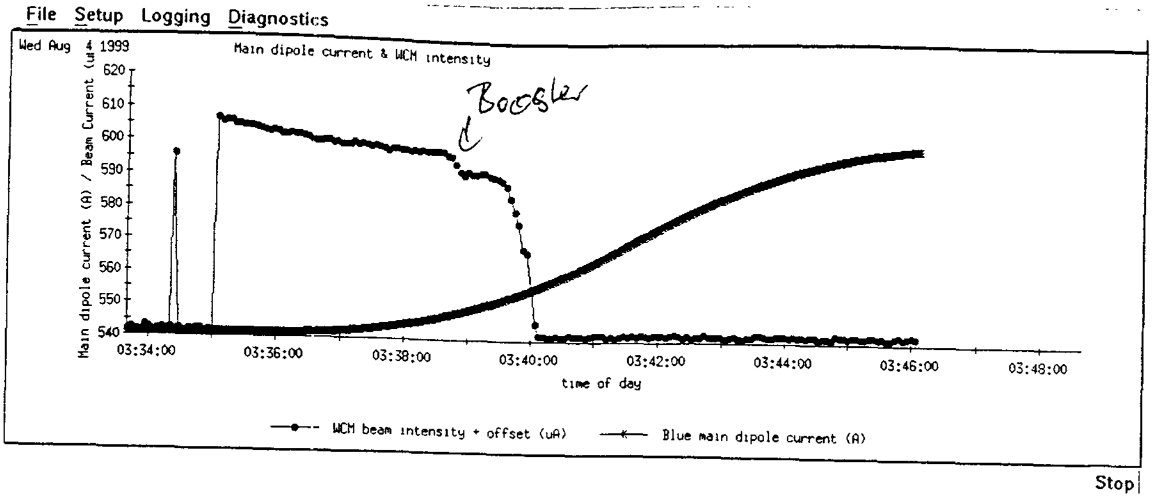
Printed: Thu Aug 5 15:27:23 1999

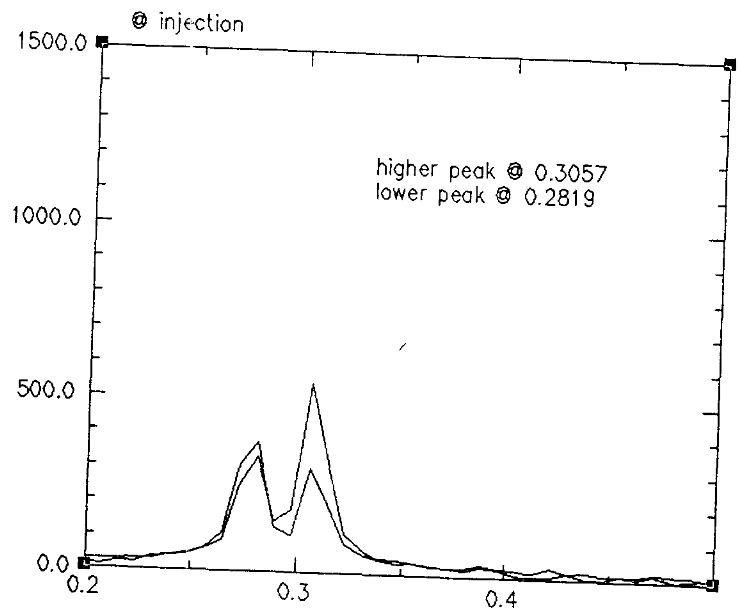


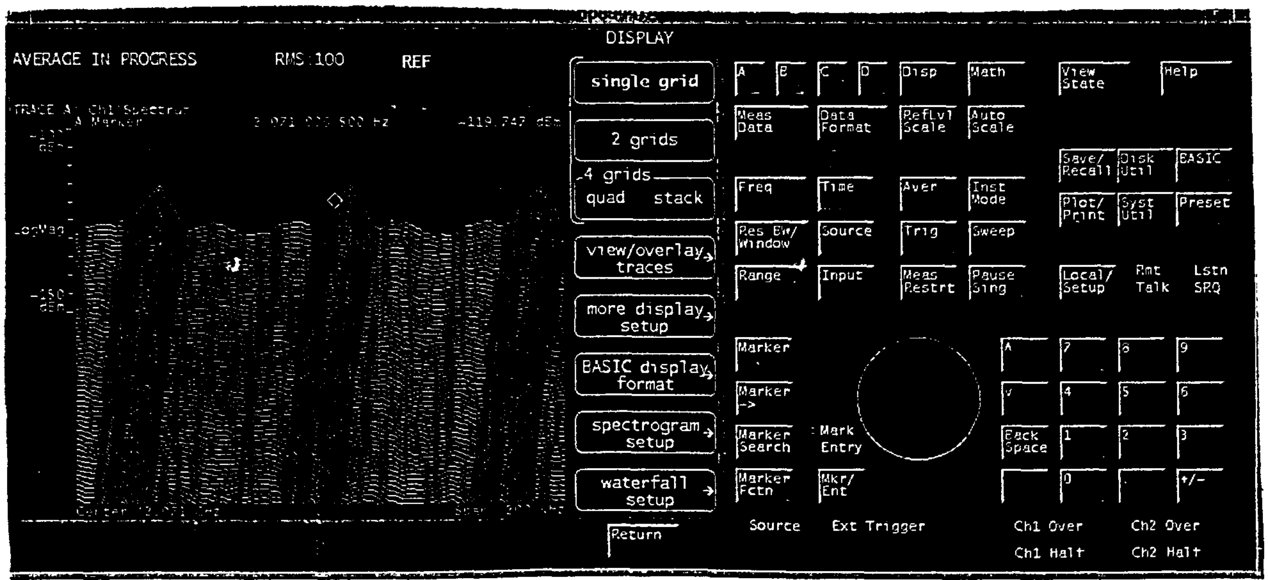
Printed: Thu Aug 5 15:27:31 1999







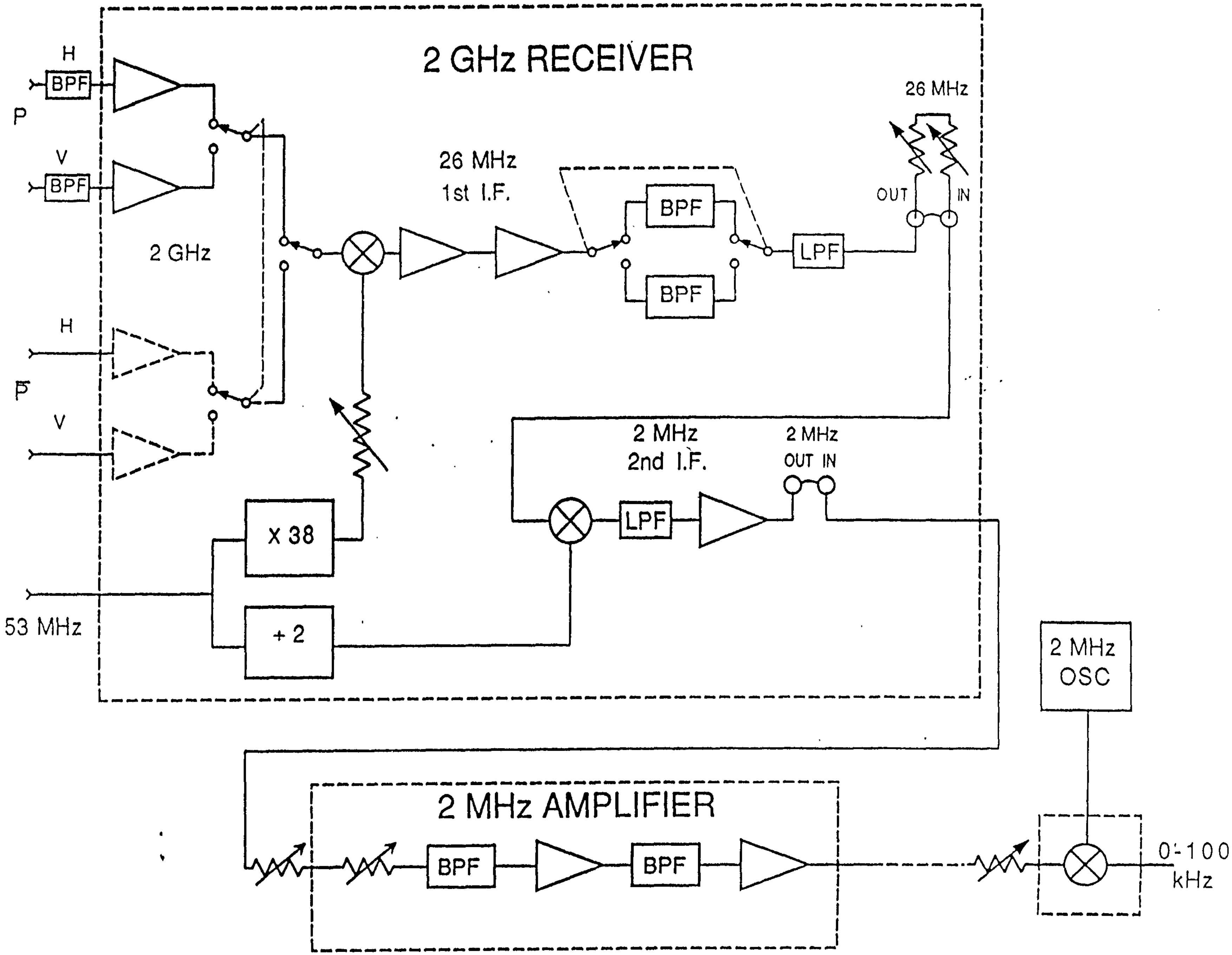




← 22.5 kHz →

time = $\frac{22.5\,\text{kHz}}{78\,\text{kHz}}$ = 0.2888 during ramp

@ injection : time measured as 0.2819


2 GHz RECEIVER
H
BPF
P
V
BPF
2 GHz
H
P̄
V
26 MHz
1st I.F.
BPF
BPF
LPF
26 MHz
OUT
IN
X 38
53 MHz
+ 2
2 MHz
2nd I.F.
LPF
2 MHz
OUT IN
2 MHz OSC
2 MHz AMPLIFIER
BPF
BPF
0-100
kHz

SCHOTTKY DETECTOR RESPONSE

	FNAL	<------------	------------	RHIC	------------>	<------------	------------	------------	------------>
		<------ Single	Bunch	------	------>	<------ Multi-	Bunch	------	------>
		p	O-16	Cu-63	Au-197	p	O-16	Cu-63	Au-197
LONGITUDINAL:									
N(E9)	500	100	8.3	2.7	1	5700	473.1	153.9	57
q	1	1	8	29	79	1	8	29	79
f-rev(kHz)	47.7	78.19	78.19	78.19	78.19	78.19	78.19	78.19	78.19
I^2=Nq^2*frev^2	1.14E+06	6.11E+05	3.25E+06	1.39E+07	3.82E+07	3.48E+07	1.85E+08	7.91E+08	2.17E+09
Ratio to FNAL	(1)	0.5	2.9	12.2	33.5	31	163	696	1912
$\Delta p/p$ †	0.001	2.50E-03	2.50E-03	2.50E-03	3.80E-03	2.50E-03	2.50E-03	2.50E-03	3.80E-03
γ	900	268.2	135.2	124.5	108.4	268.2	135.2	124.5	108.4
η	2.80E-03	1.90E-03	1.85E-03	1.84E-03	1.82E-03	1.90E-03	1.85E-03	1.84E-03	1.82E-03
I^2/Δf	4.06E+11	1.29E+11	7.01E+11	3.01E+12	5.51E+12	7.36E+12	3.99E+13	1.72E+14	3.14E+14
S/N Relative to FNAL Detector	(1)	**0.32**	**1.72**	**7.41**	**13.55**	**18**	**98**	**422**	**772**
TRANSVERSE:									
norm. emitt./π		30	30	30	43	30	30	30	43
beta-perp(m)		25	25	25	25	25	25	25	25
<x^2> (mm^2)	0.50	0.47	0.92	1.00	1.65	0.47	0.92	1.00	1.65
I^2*<x^2>/Δf	2.03E+11	6.01E+10	6.48E+11	3.02E+12	9.10E+12	3.43E+12	3.69E+13	1.72E+14	5.19E+14
S/N Relative to FNAL Detector	(1)	**0.30**	**3.19**	**14.88**	**44.79**	**16.9**	**182**	**848**	**2553**

† This is the projected value after a 10 hr. store. The initial value is smaller by roughly a factor of 5. Hence the initial power density (and signal-to-noise ratio) should be greater by that same factor.

RHIC Schottky Day One Functionality

Peter Cameron 3/1/98

Hardware

two Schottky cavities, one in each ring
- transverse mode (TM210 and TM120) center frequency - 2.1 GHz nominal
- transverse mode splitting - 4 MHz nominal
- longitudinal mode frequency - 2.5 GHz nominal

receivers for the above modes
RF Multiplexer
HP 89410 two channel Dynamic Signal Analyzer (FFT Box) with GPIB interface
Computer running LabView
VME/GPIB interface
Calibration Loop, Signal Generator, NIST-traceable Power Meter

ADO Control Functions

none for day one

LabView Displays

Schottky Spectrum Mountain Range
- at injection - saturated by coherent? damping times? gain switching?
- during acceleration - coherent again - forget about it for now?
- store - 28 MHz only means no coherent?

Betatron Tune History - look at a few synchrotron satellites
- incoherent vs coherent

Synchrotron Tune History
Emittance History - power meter
Chromaticity - probably not possible
Momentum Spread History - width of revolution line - fit with Gaussian
Beam-Beam Tune Spread and Shift History - transverse and longitudinal?
- transverse obliterates betatron synchrotron satellites
- store benchmark single beam spectrum

Non-Linear Tune Spread History - given by shape of central line

Digital Signal Analyzer Specifications

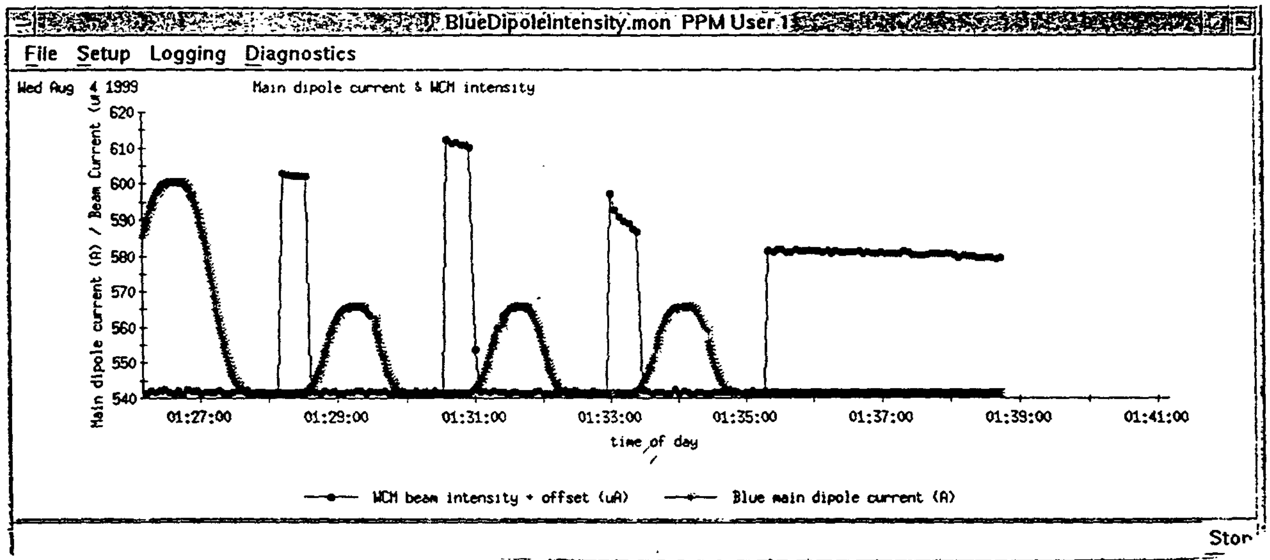
frequency range	0.0002 Hz to 10 MHz
frequency resolution in lines	51 to 3201
dynamic range	85 dB typ
channel match	+/- 0.25 dB, +/- 2.0 degrees
sensitivity	-144 dBm/Hz
memory depth	4 MBytes

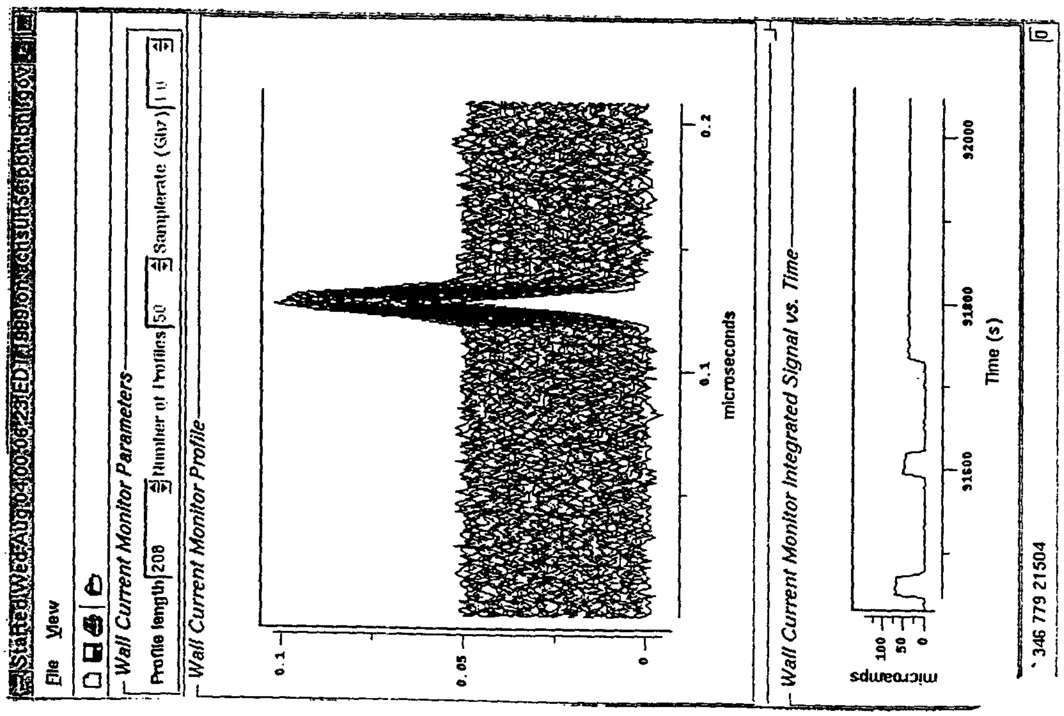
Schottky

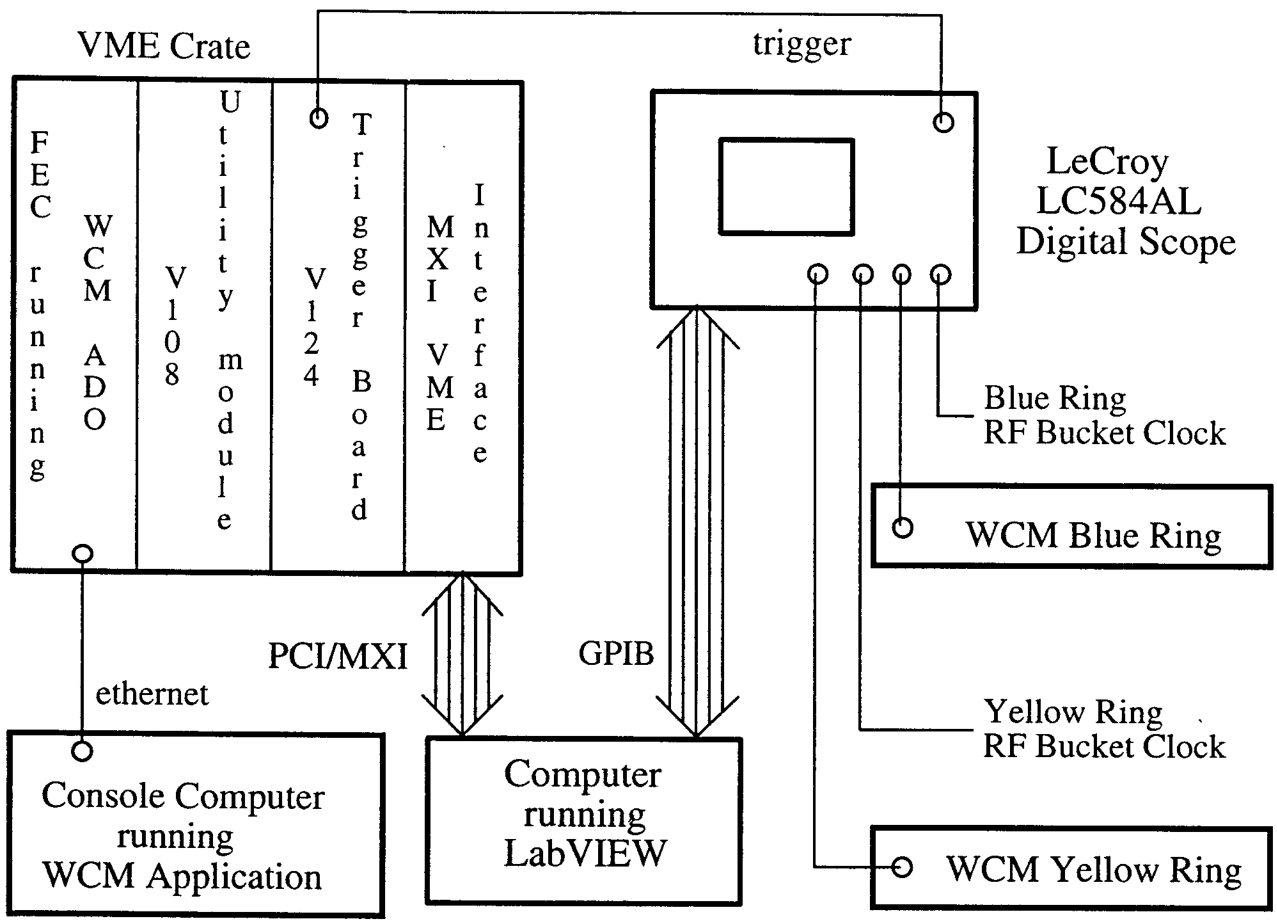
1. Best Display Award!
2. Brief description of Schottky
   a. momentum spread and line width
   b. transition
3. Dates data available – get it while you can!
   a. beam intensity
   b. lattice
   c. logbook pictures
4. Calculations
   a. tune
   b. momentum spread
   c. beam size, emittance
5. Look at and compare WCM spectra
6. Resonance behavior
   a. 12^{th} order
   b. persistence when kicking at 1 Hz
   c. excitation of other structure when kicking at 1 Hz
   d. instability structure – 89pdf
7. Tune tracking
   a. 28 MHz reference
   b. kick or lock on central satellite?
   c. Pilot bunch
8. Tying data together
   a. Schottky
   b. WCM
   c. DCCT
   d. IPM
8. The future
   a. GPIB/LabVIEW?
   b. Same computer as WCM/chromaticity?
   c. Broadband switch WCM onto DSA? Spectrum analyzer?
   d. LabVIEW 5.1 and web pages

Wall Current Monitor Results and Plans

1. Hesitancy to do development work with operational instrument - priorities
2. Block Diagram and Display
   a. Why we did it this way – integration w/ Control System
   b. RF WCM Display
   c. Schottky Display experience – LAN capability of analyzer
   d. 'Analog' Display in MCR – Spectrum analyzer?
3. Modes – Commissioning vs Operations
   1. Injection Single Trigger – lifetime < 1 sec / bunch fill pattern
   2. Injection Multiple Trigger – lifetime < a few sec
   3. Store – typ trigger 1 sec event
4. Available hardware
   a. sector 2 - 3 GHz BW
   b. IP4 - 3 GHz BW - this could be interesting
   c. sector 4 – 500 MHz BW?
5. The future
   a. GUI upgrade? Faster? FFT? Sigma?
   b. Second Scope?
   c. LAN-capable Spectrum Analyzer?
   d. Mode clarification
   e. Calibration
      1. what is the requirement?
      2. From the tunnel
      3. In situ calibrator board
      4. Frequency correction
   f. Bakeout
   g. Chromaticity – moveable BPM or Buttons?
      1. head-tail for chromaticity
      2. spectrum analysis
   h. WCM spectra – compare w/ schottky
   i. Split WCM onto Spectrum analyzer?
   j. LabVIEW 5.1 and web pages


BlueDipoleIntensity.mon PPM User 1
File Setup Logging Diagnostics
Wed Aug 4 1999
Main dipole current & WCM intensity
Main dipole current (A) / Beam Current (uA)
620
610
600
590
580
570
560
550
540
01:27:00
01:29:00
01:31:00
01:33:00
01:35:00
01:37:00
01:39:00
01:41:00
time of day
WCM beam intensity + offset (uA)
Blue main dipole current (A)
Stop


File View
Wall Current Monitor Parameters
Profile length 208
Number of Profiles 50
Samplerate (GHz)
Wall Current Monitor Profile
0.1
0.05
0
0.1
0.2
microseconds
Wall Current Monitor Integrated Signal vs. Time
100
50
0
microamps
91600
91800
92000
Time (s)
346 779 21504


VME Crate
trigger
FEC running
WCM ADO
V108
Utility module
V124
Trigger Board
MXI VME
Interface
LeCroy
LC584AL
Digital Scope
Blue Ring
RF Bucket Clock
WCM Blue Ring
PCI/MXI
GPIB
ethernet
Yellow Ring
RF Bucket Clock
Console Computer
running
WCM Application
Computer
running
LabVIEW
WCM Yellow Ring

Wall Current Monitor Recipe

P. Cameron 7/28/99

To start the app: from an xterm type "~johannes/runwcm"

If the app won't get data, type "upon cfe-2a-wcm1" to confirm that WCMManager is running on the fec. If it's not running, get Johannes to start it!

For tweaking, Pet page is available at

StartUp/start/General programs/pet/FECs/Instrumentation/WCM/bo2-wcm3

Go to Stop mode in the Pet page before making any changes!

Three useful configurations are:

INJECTION Mode single trigger – useful when beam lifetime is less than 1 second

In this mode a typical scope acquisition consists of one profile which is about 200 kbytes long. The acquisition is triggered by the FEB event. Typical settings are:

Sample Rate 1 [GS/sec]
Profile Length 200000 [bytes]
Number of Profiles 1
Trigger Event 70 (FEB event)
Revolution Delay 5
Bucket Delay 4
Scope scale 0.025 [V/div]
Scope offset 0

INJECTION Mode multiple triggers– useful when beam lifetime is less than a few seconds

In this mode a typical scope acquisition consists of 100 profiles, each about 208 bytes long, with profiles taken on the 100th turn and every 100 turns thereafter. The acquisition is triggered by the FEB event. Typical settings are:

Sample Rate 1 [GS/sec]
Profile Length 208 [bytes]
Number of Profiles 100
Trigger Event 70 (FEB event)
Revolution Delay 100
Bucket Delay 4
Scope scale 0.025 [V/div]
Scope offset 0

STORE Mode – useful when beam lifetime is more than a few seconds

In this mode a typical scope acquisition consists of 50 profiles. Each profile is 208 bytes long, and a profile is taken every 10th turn. The acquisition repeats every second, triggered by the 1 second event. Typical settings are:

Sample Rate 1 [GS/sec]
Profile Length 208 [bytes]
Number of Profiles 100
Trigger Event 74 (1 second event)
Revolution Delay 10
Bucket Delay 4
Scope scale 0.025 [V/div]
Scope offset 0

Wall Current Monitor Switching Recipe

P. Cameron

8/11/99

To Switch Rings for WCM:

1. Go to Stop mode on the Pet pages for both rings
   Pet pages for Blue and Yellow are available at
   StartUp/start/General programs/pet/FECs/Instrumentation/WCM/bo2-wcm3
   StartUp/start/General programs/pet/FECs/Instrumentation/WCM/yi2-wcm3

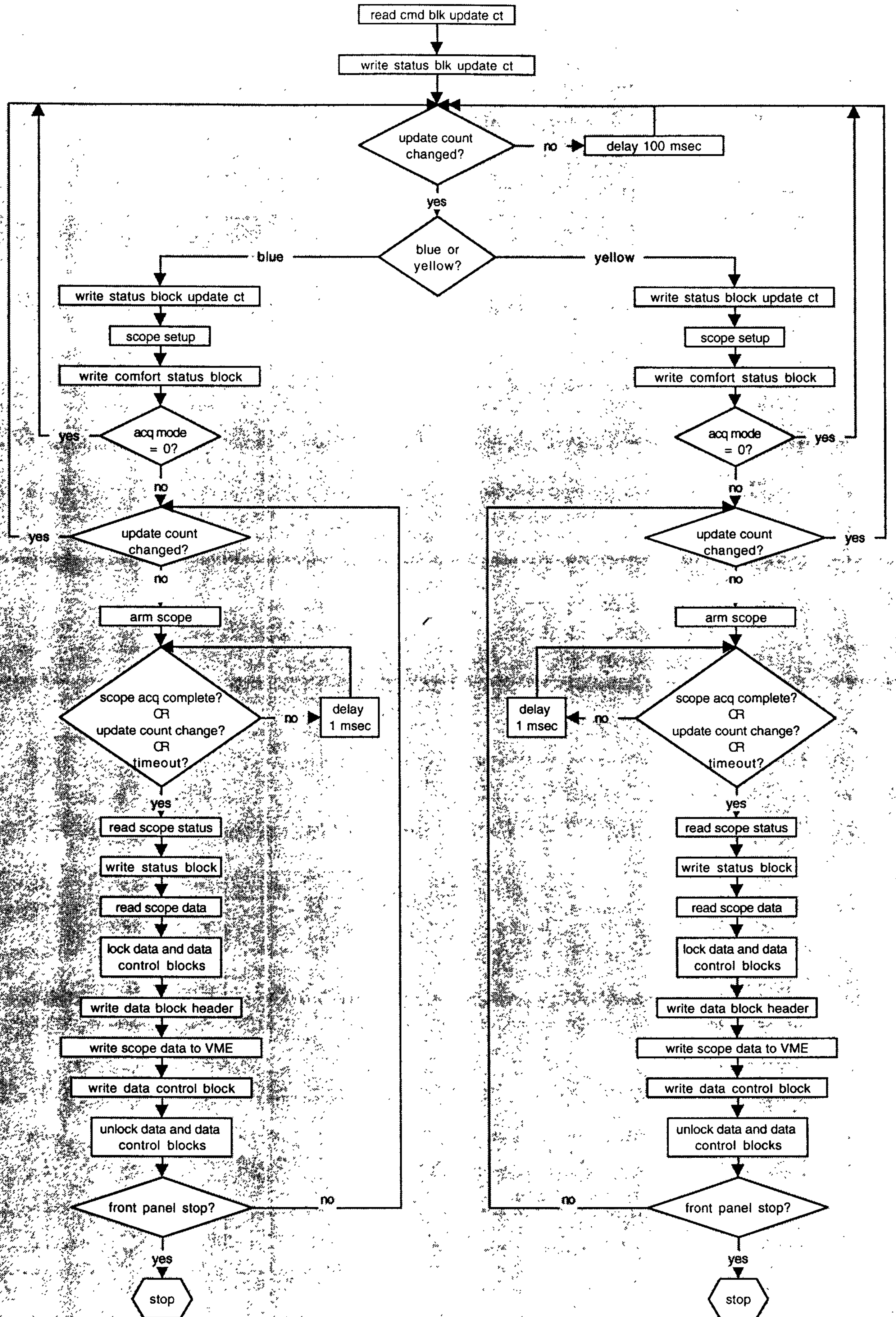
2. Close the currently running WCM App

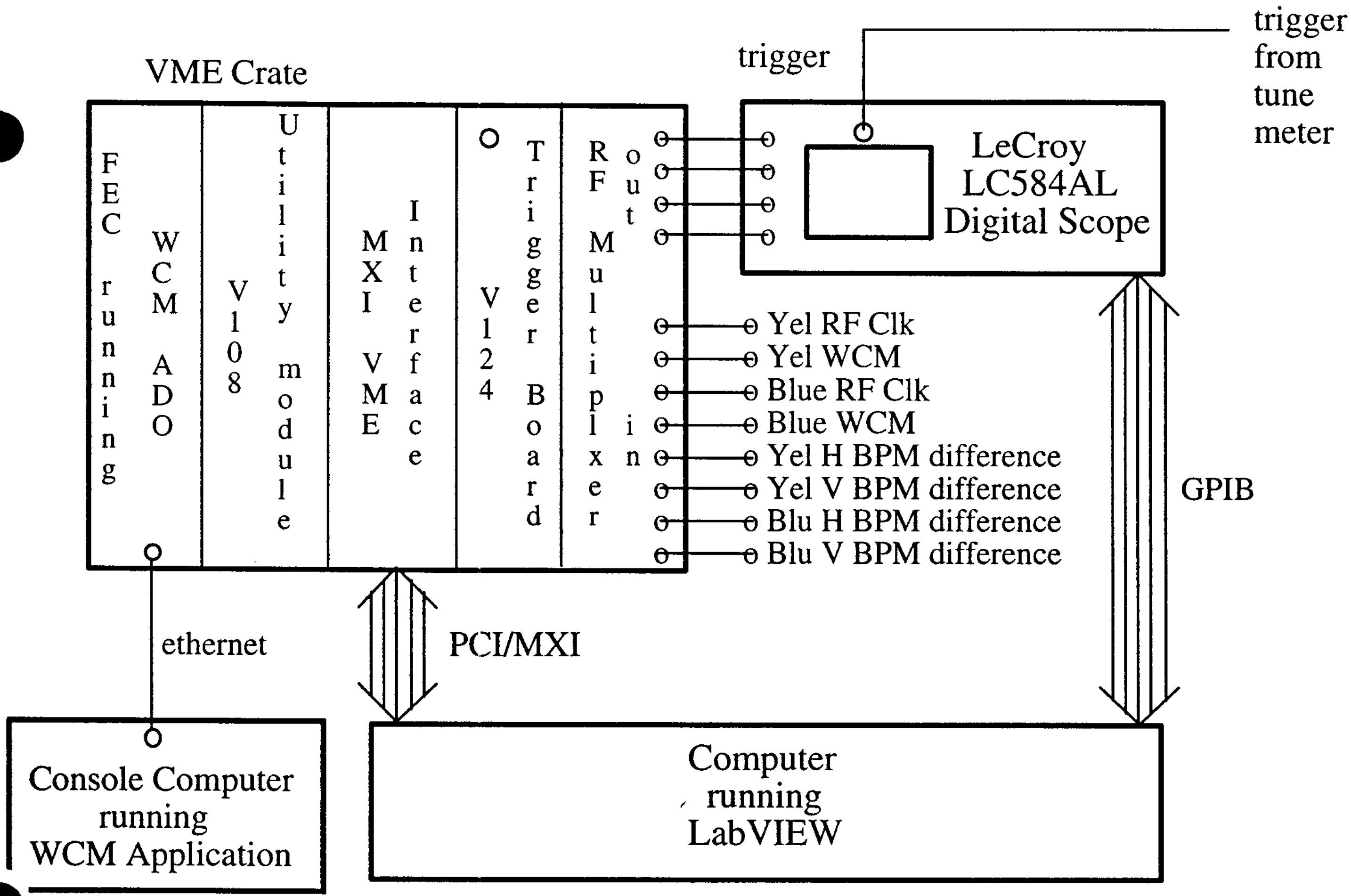
3. Open a new WCM App (from an xterm type "~johannes/runwcm")

4. Select the appropriate ring from the prompt presented by the App

5. Change from Stop to Injection or Store mode on the Pet page.

6. See WCM Recipe in the recipe book for further information, if required.


read cmd blk update ct
write status blk update ct
update count changed?
no
delay 100 msec
yes
blue or yellow?
blue
yellow
write status block update ct
scope setup
write comfort status block
acq mode = 0?
yes
no
update count changed?
yes
no
arm scope
scope acq complete? OR update count change? OR timeout?
no
delay 1 msec
yes
read scope status
write status block
read scope data
lock data and data control blocks
write data block header
write scope data to VME
write data control block
unlock data and data control blocks
front panel stop?
no
yes
stop
write status block update ct
scope setup
write comfort status block
acq mode = 0?
yes
no
update count changed?
yes
no
arm scope
delay 1 msec
no
scope acq complete? OR update count change? OR timeout?
yes
read scope status
write status block
read scope data
lock data and data control blocks
write data block header
write scope data to VME
write data control block
unlock data and data control blocks
no
front panel stop?
yes
stop



VME Crate
FEC running
WCM ADO
V108
Utility module
MXI VME
Interface
V124
Trigger Board
RF Multiplexer
out
in
trigger
trigger from tune meter
LeCroy LC584AL Digital Scope
Yel RF Clk
Yel WCM
Blue RF Clk
Blue WCM
Yel H BPM difference
Yel V BPM difference
Blu H BPM difference
Blu V BPM difference
GPIB
ethernet
PCI/MXI
Console Computer running WCM Application
Computer running LabVIEW

IPM STATUS

HARDWARE TASKS THAT HAVE TO BE DONE

1. 9 preamps need to be built, tested and calibrated.

   36 circuit boards to be modified, stuffed and debugged
   Gain adjusted for each channel (288 channels)
   Boards installed in chassis boxes and wiring checked

2. 3 magnets assembled, Bob and John are working on this.

3. 4 magnets installed in tunnel, Bob will schedule

4. 4 systems: preamps installed, connected and all channels checked.

5. Rest of Hytec digitizers checked

6. Lemo connectors ordered and timing cables made

7. 2 VME crates modified

8. 2 ECL fanout cards assembled (these might be done)

OPTIONAL HARDWARE

9. One gas leak system is being built as SNS prototype. If three others are desired need RHIC money.

10. The 2 o'clock IPM's work with digitizers in ICR. The 1 o'clock IPM's may require VME crates in tunnel?

MCP has limited lifetime.
Need to optimize use - what do we need it for?

RHIC Abort System: (diagnostics?) L Ahrens 17Sep99

System status for '99 run:

Blue system available. Known shortfalls: design voltage 33 kV, thyratron prefires if run above 30 kV, ring vacuum in kicker region deteriorates and pumps trip with pulsing at 25 kV. No connection with the abort link, either to pull or to be pulled.

Yellow system (kicker PFN) not yet available

A planned diagnostic to signal deterioration of the first section of the dump - a thermocouple array, not available ... still not moving forward.

Beam results:

Above constraints did not impact the beam activity during the run. Abort system commissioning with the Blue system progressed to the point of checking and setting the timing of the abort kicker pulse. With this timing, and the "book" value for the kicker amplitude, the injected beam was seen to be completely removed when the kicker was pulsed. This mode was invoked for several weeks of running in an automatic sense by triggering the kicker prior to beginning an injection sequence. The loss pattern associated with the kick - at injection energy - was very local and was documented (pic 1).

This setup was adequate for the running situation. One attempt to calibrate in kick gave unlikely results. (pics 2) kicker current, and 3) beam and kicker pickup on local BPM cable) A more involved test - with a very weak kick accomplished by timing adjustments, and capturing the difference orbit caused by the kick - was planned but not carried out.

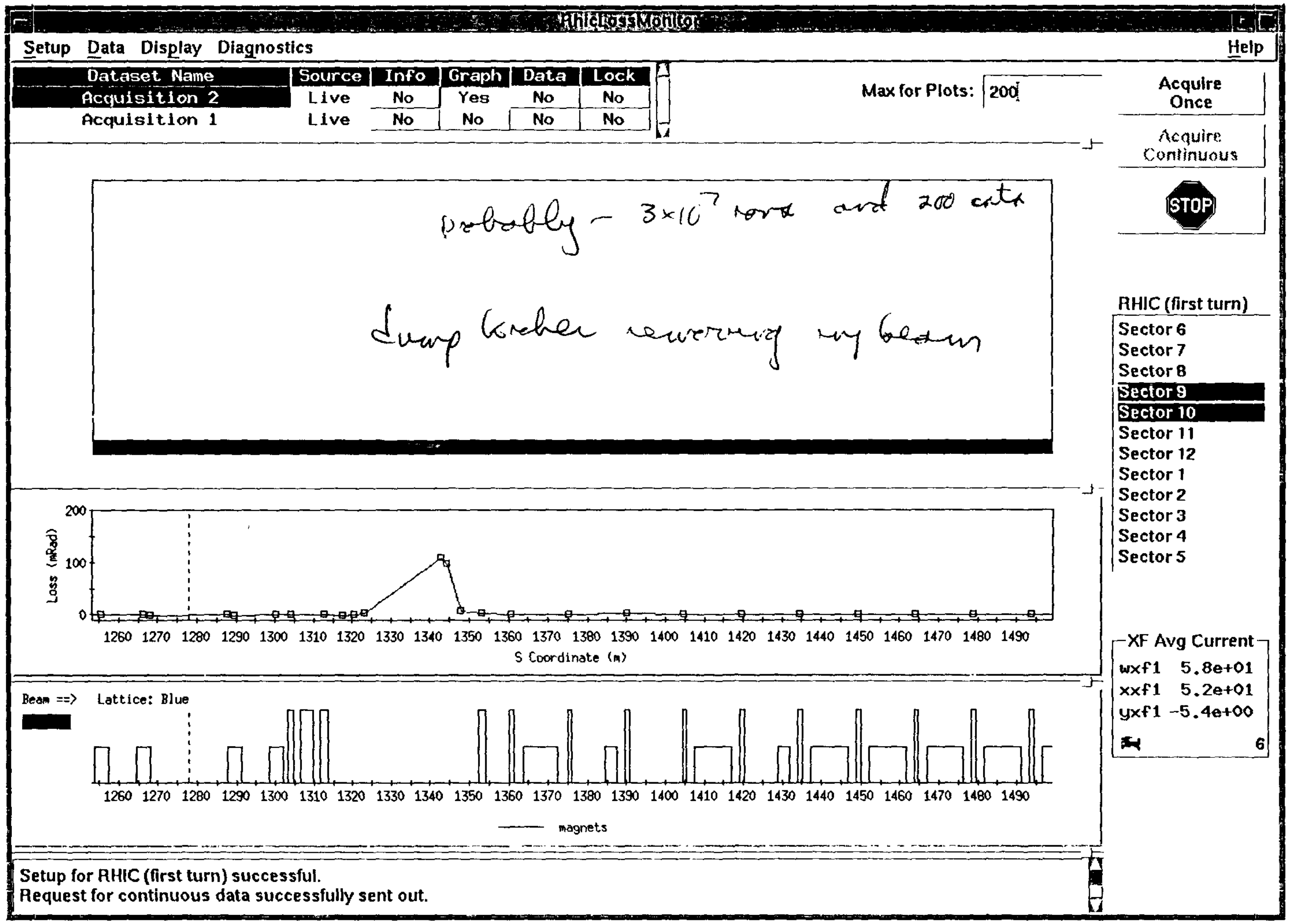
Present system status:

With conditioning, expect both kickers to function at 30 kV - which is thought to be adequate. With a planned bake of the magnets, expect the vacuum problem associated with high voltage pulsing to disappear.

The Yellow ring system is being tested at high voltage. Several minor changes in circuitry have been made to give a more robust system.

Electronics for analogue signals to MADC channels , and for outputs to the abort link are being built.

Diagnostics? Loss monitors promising. BPM located 10 meters down stream of the kicker may be useful. It saw a large kicker induced pulse which may make interpretation difficult.


RhicLossMonitor
Setup Data Display Diagnostics Help
Dataset Name | Source | Info | Graph | Data | Lock
Acquisition 2 | Live | No | Yes | No | No
Acquisition 1 | Live | No | No | No | No
Max for Plots: 200
Acquire Once
Acquire Continuous
STOP
probably ~ 3×10^7 ions and 200 cnts
dump kicker removing my beam
RHIC (first turn)
Sector 6
Sector 7
Sector 8
Sector 9
Sector 10
Sector 11
Sector 12
Sector 1
Sector 2
Sector 3
Sector 4
Sector 5
Loss (mRad)
S Coordinate (m)
XF Avg Current
wxf1 5.8e+01
xxf1 5.2e+01
yxf1 -5.4e+00
6
Beam ==>
Lattice: Blue
magnets
Setup for RHIC (first turn) successful.
Request for continuous data successfully sent out.

11

pic 2 + 3

31-Jul-99
7:31:42

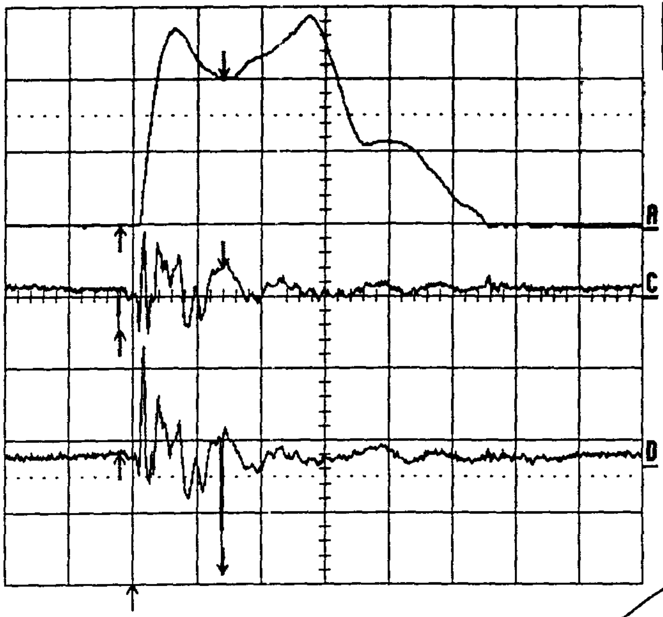
REMOTE ENABLE

GO TO
LOCAL

C: M3
5 μs
4.00 mV
-3.38 mV

D: M4
5 μs
4.00 mV
6.77 mV

A: M1
5 μs
0.50 V
-1.016 V



.004

.006

delay kicker to 216

.007

kicker delay = 104

[amp 28.5 mm, .1, .6 mm]

.1 s

1 .5 V DC
2 50 mV DC
3 1 V DC
4 5 V DC

Ext DC 420 mV 50Ω

Δt -7.975 μs 1/Δt -125.39 kHz

50 kS/s

NORMAL

at ave amp [-16.7, -2.4]

Should be 8 μs

here the kicker amp = 1.016V

position = (28.5, .5)

at end position (-16.7, -2.4)

1, this kick (45.2, mm)

lattice J.S.

Dejan Trbojevic
September 17, 1999

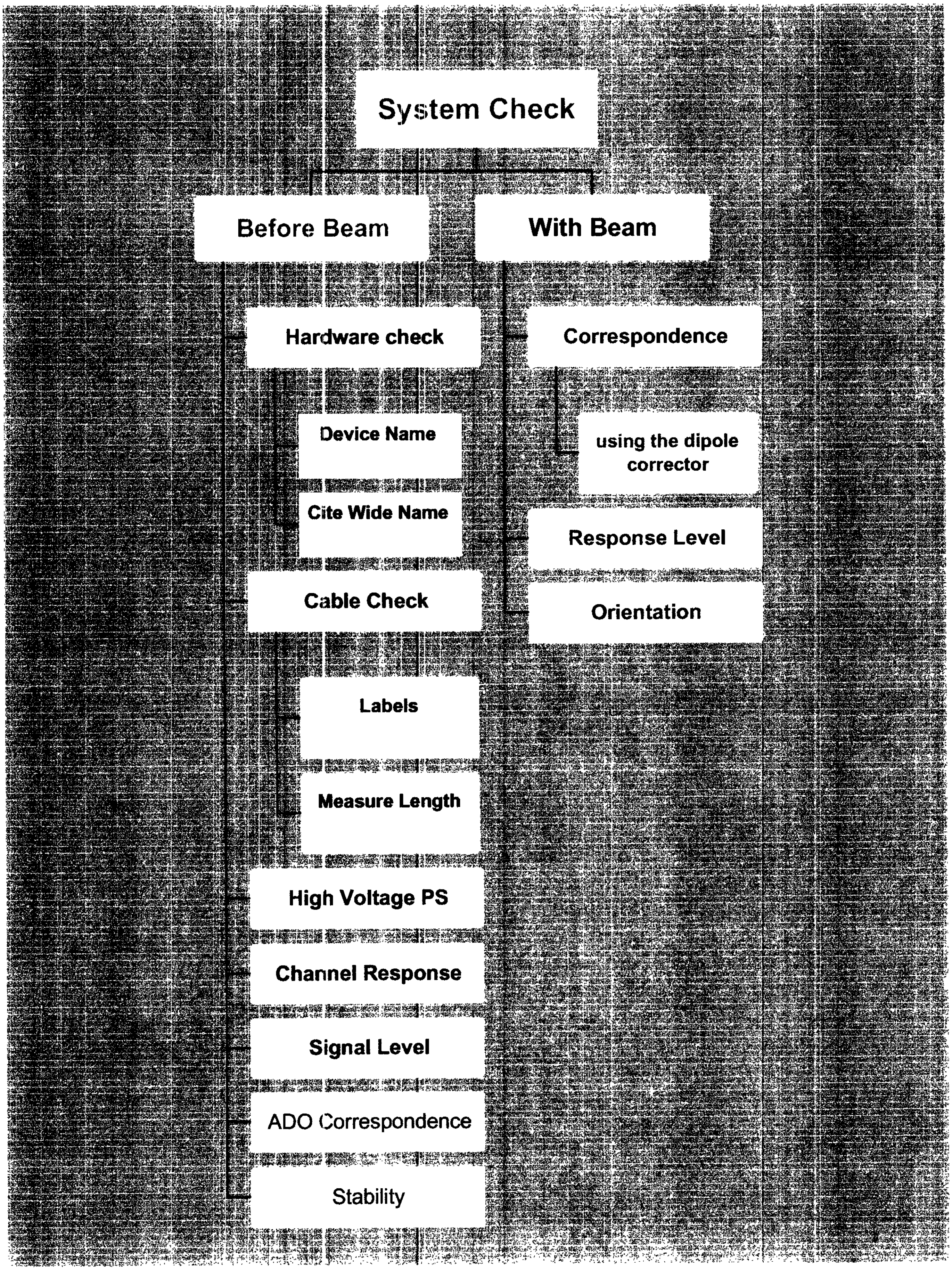
Stony Brook University RHIC Retreat

Beam Diagnostics & Instrumentation

- **Major Points:**
  - **Present Status of the Beam Diagnostic Systems**
  - Great start-up for some, few problems with others
  - **What do we need to do within next two months to improve the present systems ?**
  - **What would be nice to have during the next run ?**

What was working well in the previous run?

- **Loss monitor system** - why ?
  - Great dedication and the **best integration** and **check-out**
- Wall current monitors
- Single ionization profile monitor
- DCCT 's - current transformers
- Schottky detector - showed us fantastic possibilities
- Tune meter - hardware partially OK, software fixed after initial problems
- BPM 's with few problems????
- Flags in the Transfer line - do you really need to turn off every other flag to be sure what you want to measure ?



System Check
Before Beam
With Beam
Hardware check
Device Name
Cite Wide Name
Cable Check
Labels
Measure Length
High Voltage PS
Channel Response
Signal Level
ADO Correspondence
Stability
Correspondence
using the dipole corrector
Response Level
Orientation

What should we do during preparations?

- Check the **BPM system** thoroughly and make it reliable
- **Tune Meter** - increase the kick strength (may be use the abort kickers and injection kickers instead - Mike Brennan suggested)
- Complete the **Ionization Profile Monitors** and make them operational from the control room
- Make a connection between the RF controls and the tune meter - chromaticity
- Make the DCCT and Wall Current Monitor more user friendly
- **Schottky detectors** - provide the signals along the ramp

if possible:

- Make the AC dipole
- Project the beam profiles from the Schottky detector into the betatron tune diagram

Dejan Trbojevic:

Report from the Session on the Beam Instrumentation & Diagnostics

Stony Brook - September 18, 1999

Outlines:

- **Participants:** Mike Brennan, Roger Connolly, Dejan Trbojevic, Steve Peggs, Harald Hahn, Chris Degan, Roger Lee, Mei Bai, Peter Cameron, Leif Ahrens
- **Presentations:**
  - Peter Cameron : Schottky Detectors and Wall Current Monitors
  - Roger Connolly : Ionization Profile Monitor
  - Roger Connolly, Dejan Trbojevic, and Mike Brennan: Tune Meter
  - Leif Ahrens : Abort Kickers
- **Discussion**
- **Conclusion**

Summary of the Pete Cameron's Presentation:

- **Shottky Monitors**
  - Introduction: Results from Fermilab
  - Showed our nice results from the summer run
  - The missing "conversion box" should arrive this month. It would allow monitoring along the acceleration ramp of the betatron tunes (as side bands of the revolution frequency).
  - Very promising technique but requires additional preparation to become user friendly tool.
  - Possibility to project the beam onto the betatron tunes diagram n_x and n_y by using the power spectrum mode.
- **Wall Current Monitor**
  - Nice results from the summer run
  - For the next run **REQUIRES ADDITIONAL SCOPE** IF WE WANT TO LOOKAT BOTH BEAM AT THE SAME TIME!!!!
  - Possible Chromaticity Measurements (as had been demonstrated in HERA)
  - Longitudinal Emittance Measurements
  - Additional work on the application code to make more user friendly communication

Summary of the Roger Connoly's Presentation:

- **Ionization Profile Monitors** - Introduction
- Results from the summer run showed that the SYSTEM IS COMMISSIONED but not fully operational
- Warning about the SHORT LIFE TIME OF THE MULTI-CHANNEL PLATE DETECTOR
- For the next run it is essential to finish completely the system and build **NINE PREAMPLIFIERS -THIS REQUIRES IMMEDATE START - FIND THE OUTSIDE CONTRACTOR AND FINISH IT RIGHT AWAY** (Company "Circuit Technology)!!!!
- No problem to assemble the rest of the magnets
- FOR THE TURN BY TURN OPERATION IT WOULD REQUIRE ADDITIONAL VARIABLE LEAK VALVES
- The application code should be finalized

Summary of the Leif Ahrens's Presentation:

- **Beam Abort System** - only the "Blue" was checked during the summer run
- There were vacuum trips due to unbaked kicker pipes
- Thermocouple array detector in front of the carbon block is still a "mystery" from the operational point (we need Richard Witkover's help?).
- The Abort Kickers did remove the beam from the machine but the system is not commissioned yet!
- The results showed a beam movement of the x=-45 mm at the right position of the kicker voltage - this was shown by the pet page readout.
- **ABORT SYSTEM IN BOTH RINGS NEEDS TO BE COMMISSIONED BY DEDICATED SHIFTS**

Roger Connoly, Mike Brennan, and Dejan Trbojevic :

Tune Meter Discussion - and conclusions are presented at the retreat by Mike Brennan